Issued April 29, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

FOREST SERVICE—BULLETIN 87.

HENRY S. GRAVES, Forester.

EUCALYPTS IN FLORIDA.

BY

RAPHAEL ZON,
CHIEF OF SILVICS,

AND

JOHN M. BRISCOE,
FOREST ASSISTANT.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

PLATE I.

ELEVEN-YEAR-OLD WINDBREAK OF RED MAHOGANY (EUCALYPTUS RESINIFERA), NEVER KILLED BACK BY FROST; ON POOR, SANDY SOIL AT COURTENAY, MERRITTS ISLAND.

Issued April 29, 1911.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE—BULLETIN 87.
HENRY S. GRAVES, Forester.

EUCALYPTS IN FLORIDA.

BY

RAPHAEL ZON,
CHIEF OF SILVICS,
AND
JOHN M. BRISCOE,
FOREST ASSISTANT.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., January 11, 1911.

SIR: I have the honor to transmit herewith a manuscript entitled "Eucalypts in Florida," by Raphael Zon, Chief of Silvics, and John M. Briscoe, Forest Assistant, and to recommend its publication as Bulletin 87 of the Forest Service. The five plates and one text figure accompanying the manuscript are necessary for its proper illustration.

Respectfully,

HENRY S. GRAVES,
Forester.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

ILLUSTRATIONS.

PLATES.

TEXT FIGURE.

EUCALYPTS IN FLORIDA.

SUITABILITY OF FLORIDA TO EUCALYPTUS CULTURE.

The successful growing of eucalypts in southern California has raised the question whether these trees can be grown in other portions of the southern United States where climatic conditions may be favorable. Next to southern California, Florida promises most for the growing of this genus.

In January, 1910, the Forest Service began an investigation to learn what species of eucalypts might be successfully grown in the different sections of that State. The first step of this investigation consisted chiefly in finding as many as possible of the eucalyptus trees planted in the State and determining their botanical identity, their rapidity of growth, and their frost hardiness.

Sixteen species of eucalypts were found growing with varying degrees of success at 27 different places in Florida.

The results of this preliminary study prove that certain eucalypts are climatically well suited to the southern part of Florida. Just how profitable they may be in commercial plantations is yet to be determined by actual trial. To make this trial the Forest Service, in cooperation with the State and with several boards of trade in Florida, is undertaking experimental plantations of eucalypts on a scale much larger than has hitherto been attempted. Until conclusive results are obtained from this investigation, any commercial planting of eucalypts by individuals should be made cautiously, and only after a close study of the climatic and soil requirements of the species planted.

WHERE EUCALYPTS HAVE BEEN GROWN.

The eucalypts are natives of Australia and Tasmania. They are broad-leaved, evergreen trees belonging to the family Myrtacæ. Their name is derived from two Greek words meaning "well concealed," and was given to this genus by the French botanist, l'Heritier, who discovered it in Tasmania in 1788, because the flowers, when immature, are well hidden under a lid or cap. The first species discovered by l'Heritier was *Eucalyptus obliqua*. Since then several hundred species have been described.

From their native home they have been introduced into a number of other countries where the climatic conditions were more or less suited to their growth. They have been successfully planted in the Mediterranean region, as in southern France, on the island of

Corsica, and in Algeria; they have been planted on denuded mountain slopes near the sea in Spain and Portugal; and in Italy, particularly near Rome and Naples, they have been used for lowering the water table in swampy soils. In America some of the eucalypts have been introduced into California, where they have changed the entire landscape of the southern part of that State and have proved of benefit in furnishing quickly a large amount of fuel wood, timber for ties, posts, and similar uses. Eucalpyts have been planted to a small extent in Arizona, Florida, and Texas. In Cuba and Hawaii there are large plantations of eucalypts, and they have been extensively planted in South America, particularly in Brazil.

As a general rule, the commercial species of eucalypts may be introduced into any region in which citrus fruits and the olive will grow in the open. They apparently do best in a climate which permits of a distinct period of vegetative rest during the year, and are capable of withstanding temperature below freezing if the period of the low temperature is not long sustained and if it is coincident with the period of vegetative rest. The decisive factor is temperature—not the average temperature, but the absolute maximum and minimum temperatures—extremes in either of which are apt to prove fatal. Precipitation is of less importance, since the tree thrives in regions that have an average annual precipitation of less than 18 inches, and in regions in which the annual rainfall is more than 70 inches.

CONDITIONS IN FLORIDA.

A comparison of the climatic conditions which prevail in Australia, the native home of the eucalyptus, and in regions in which eucalypts have been successfully introduced, with those in Florida brings out the fact that while the climate of southern Florida, on the whole, is well adapted to the growing of eucalypts, there are certain peculiar conditions which must be taken into account in the selection of the species and methods of cultivation.

CLIMATE.

TABLE 1.—*Comparison of climate of regions in which eucalypts are grown.*

Location.	Average of absolute maximum temperatures.	Average of absolute minimum temperatures.	Average annual precipitation.
	°F.	°F.	*Inches.*
Brazil (Sao Paulo) (average for 1905–1908)	96.8	30.0	71.3
Australia	114.2	25.5	31.3
Southern California (eucalyptus zone)	108.6	21.0	18.9
Southern Florida (below the twenty-ninth parallel)	98.0	21.2	54.1

TABLE 2.—*Comparison of climate of Australia and Florida.*

Location.	Average of absolute maximum temperatures.	Average of absolute minimum temperatures.	Average annual precipitation.
AUSTRALIA (EUCALYPTUS REGION).			
	°F.	°F.	*Inches.*
Queensland	110.1	26.8	56.03
New South Wales	115.2	[1] 16.0	32.76
Victoria	116.6	26.4	27.28
South Australia	114.1	25.9	17.68
West Australia	115.0	32.5	22.55
FLORIDA, SOUTH FROM EUSTIS (BELOW THE TWENTY-NINTH PARALLEL).			
Eustis	104	16	49.6
Tampa	96	19	53.1
Bartow	100	18	54.5
Fort Myers	94	24	55.1
Miami	96	29	58.3

[1] Except at 4,600 feet elevation=0.5°.

This comparison shows that both the maximum and the minimum temperatures in Australia are higher than in Florida, and that the total annual rainfall in Florida is much greater than in any part of Australia.

The greatest difference between the climates of Florida and of southern California, in the zones of the two States in which the culture of eucalyptus is possible, is in the amount of precipitation and its distribution throughout the year. This difference, however, affects the relative humidity of the air and therefore modifies the effect of the temperature upon vegetation. The differences may be summarized as follows:

1. In southern California the maximum temperature is over 10° higher than it is in Florida, but the air is dry. Southern California, average maximum temperature, 108.6°; Florida, average maximum temperature, 98°.

2. The minimum temperatures are very nearly the same. Southern California, average minimum temperature, 21°; Florida, average minimum temperature, 21.2°.

3. The average annual precipitation is much greater in Florida. Southern California, average annual precipitation, 18.9 inches; Florida, average annual precipitation, 54.1 inches.

4. The relative humidity is much greater in Florida.

5. In southern California the rainy season comes in the winter months (December, January, and February), while in Florida the heaviest rainfall occurs in the summer months (June, July, and August), but the total precipitation is more evenly distributed

throughout the year than in southern California. In California during the three months of least rainfall in most cases less than 1 inch is recorded, while in Florida the records show no case less than 5.5 inches for a similar period. While California has distinct wet and dry seasons, and is in some places semiarid, Florida has a more uniform climate and less seasonal variation, and in the southern part at least is semitropical.

6. In California the season of cold is longer and is fairly well defined. In Florida cold spells are spasmodic, and while they occur, as a rule, only during the three winter months (December, January, and February), yet the drop in temperature may be sudden, and may come just before or just after much higher temperature.

7. Florida is, moreover, about 3 degrees south of the most southern part of California, and is in about the same latitude (30°) north of the Equator that South Australia, the native home of the eucalypt, is south.

Of all the countries in which eucalyptus has been successfully introduced, the climate of southern Brazil comes closest to that of Florida. In that part of Brazil where eucalypts are raised on a commercial scale, and where meteorological observations have been carried on over a series of years, the average maximum temperature for the period from 1905 to 1908 was 96.8° F., very close to that of Florida. The average annual precipitation for the same period in Brazil gives 71.3 inches, more than in Florida and more than in any other countries where eucalypts are grown. The absolute minimum temperature in Brazil for the same period, however, is higher than in Australia, southern California, or Florida. Brazil, however, has this advantage over Florida, that it is free from the cold northern winds which often cause a sudden drop in temperature.

In Brazil, as in Florida, the rainy season comes during the summer, but there are distinct dry months during which very little or no rain falls. This fact, together with the higher minimum temperature, creates conditions in Brazil more favorable for the growing of eucalypts than are found anywhere in California or Florida, and the growth of eucalypts is more rapid in South America.

In Florida, then, there is no such well-marked period of vegetative rest as is found in most other countries where eucalypts have been successfully cultivated, and only those species which can withstand a humid atmosphere and are able to resist frosts could be expected to do well. In the humid atmosphere which prevails in Florida, and with the less pronounced period of vegetative rest, freezing temperatures are likely to do greater damage to the trees than in regions in which the low temperatures occur only during the periods of rest.

The region in Florida in which eucalypts can be successfully grown may thus be roughly defined as the orange belt. In some cases, and with some species of eucalypts, this range may be safely extended, but as a rule these trees should not be planted where frost makes the cultivation of the orange unprofitable.

This limits the potential climatic range for plantations of eucalypts to that portion of the peninsula south of the twenty-ninth parallel of latitude, or to about 40 per cent of the total area of the State.

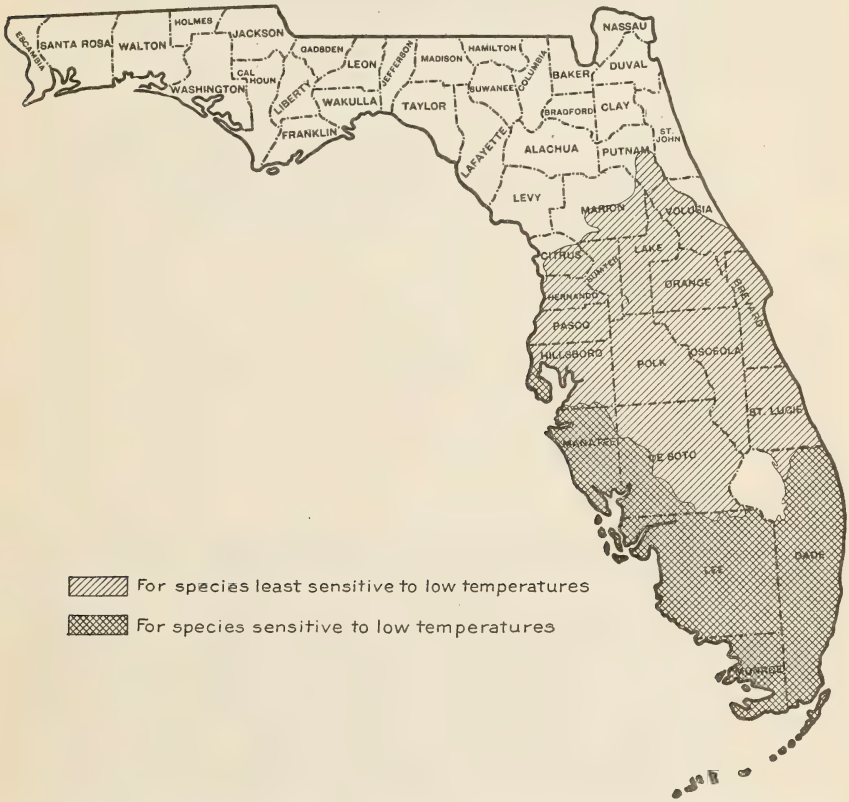


FIG. 1. Map of Florida, showing approximately the area climatically adapted to eucalypts.

On the accompanying map (fig. 1) are indicated the areas which are climatically suited for growing certain species of eucalyptus. The lighter shading indicates the areas where the least frost-sensitive species may be planted, while the most frost sensitive should not be planted outside of the area indicated by the darker shading.

TOPOGRAPHY AND SOIL.

Most of the eucalypts need protection from wind. Their rapid growth and slender form make them especially subject to injuries from this source. In this respect, Florida is less favorably situated than Australia, California, or Brazil, which possess mountain ranges. Nowhere in Florida is the elevation more than 300 feet above sea level. Moreover, this elevation is attained only in the interior of the north and northwestern portions. Over two-fifths of the State lies but little above sea level, and there are large areas of swamp and sawgrass morass, of which the largest consolidated body is the Everglades. This low, flat country is surrounded on three sides by sea. This makes the climate almost insular and tends to lessen the extremes of temperature, but, at the same time, exposes the land to wind on all sides. The probable damage to eucalyptus plantations from wind will have to be taken into account and counteracted, either by spacing closely or by staking the trees when they are young.

The various species of eucalypts differ considerably in their soil requirements. Most of them, however, can thrive on light, sandy soils, provided they are deep and the water table is not too far from the surface. From the fact that sandy soils predominate, except in the Everglades, there are undoubtedly large areas which have a soil suitable for the growth of eucalypts. The adaptability of the different species to the various soils of Florida, such as coquina, heavy marl, and peat, can be determined only by experiment. Where the limestone rock is close to the surface, or where the sand is underlaid at no great depth with hardpan, the eucalypts may fail entirely or attain only a stunted growth. The hardpan, which is of fairly common occurrence, consists of a substratum of clay or very fine sand, the particles of which have been cemented together by deposits of oxides of iron. It is well-nigh impervious to moisture, and ordinarily the roots of trees are unable to penetrate it unless it has been previously broken up. Wherever this hardpan exists it is sure to interfere more or less with the development of the trees; they will be apt to form a flat, spreading root system, as shown by wind-thrown pines in these localities. The timber now growing on the several soils may serve as a general indication of their suitability for eucalypts.

In many places the ground water is very near the surface, and while this will not be disadvantageous to some species it will not prove beneficial to all. Some of them can not stand in water-soaked soil. Therefore great care must be taken to avoid locating plantations on situations where such adverse conditions exist.

The only species, therefore, which can be safely tried in Florida are either those which can adapt themselves to light, sandy soils, or those which can stand superabundant soil moisture.

Fig. 1.—Jarrah (Eucalyptus marginata). Sprout from stump of tree killed back by frost. Diameter, 8 inches; height, 42 feet. Eustis.

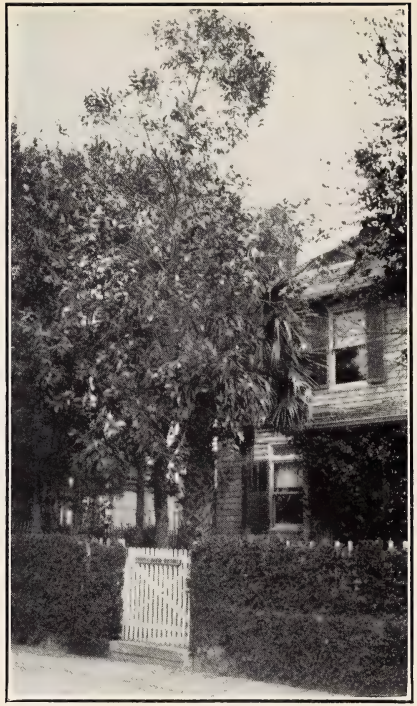


Fig. 2.—Swamp Mahogany (Eucalyptus robusta). Sprout from stump of tree planted 30 years ago, repeatedly killed back by frost. Diameter, 7.9 inches; height, 25 feet. St. Augustine.

FIG. 1.—EIGHTEEN-YEAR-OLD RED MAHOGANY (EUCALYPTUS RESINIFERA) NEVER INJURED BY FROST. DIAMETER, 39.3 INCHES; HEIGHT, 80 FEET. SEVEN OAKS, NEAR CLEARWATER.

FIG. 2.—CLOSER VIEW OF THE SAME TREE.

EARLY INTRODUCTION OF EUCALYPTS INTO FLORIDA.

The date of the earliest plantation of eucalypts in Florida, so far as can be determined authentically, was 1878, when Rev. A. H. White planted some six or eight species at Georgiana, on Merritts Island. He obtained the seed from some Government department in Washington, possibly from the Patent Office, which at that time distributed seeds.

Among the species which he tried were *amygdalina*, *gonicalyx*, *marginata*, *melliodora*, *rostrata*, and *stuartiana*. Of these there remains to-day only one tree, probably *E. gonicalyx*, which is over 2 feet in diameter and has resisted the severe gales to which it is exposed, as well as the freeze of 1894–95. Up to 1893 *E. rostrata* had made the best growth and was then over 70 feet high; but in that year, together with *E. amygdalina*, it was thrown in a heavy windstorm.

In the eighties some nurserymen, notably Reasoner Bros., at Oneco, and the American Exotic Nurseries, at Seven Oaks, near Clearwater, listed a number of eucalyptus species in their catalogues. The species selected for planting in Florida were not made with any particular reference to climate or soil conditions. There was no experience as to the best time of planting nor the methods of handling the extremely tender seedlings. Very few trees survived, and those which could be traced to these sources were chiefly in Manatee County. At Seven Oaks specimens of *E. resinifera* and *E. robusta* still exist. The *E. resinifera* measured 39.3 inches in diameter at breast-height and was 80 feet high and only 18 years old at the time of this study. (See Pl. III.)

The severe frost in the winter of 1894–95, which proved so discouraging to the orange growers, turned their attention to other crops. Among the alternatives which then suggested themselves, besides the production of garden truck, was the growing of eucalypts, and a large number of the eucalyptus trees now growing in Florida date from that suggestion. A peculiar coincidence in this connection is that at about the same time that the planting of eucalypts began to attract more attention, the local nurserymen practically discontinued the handling of eucalyptus stock. Possibly they were discouraged by the results of the frost, or found the stock more difficult to handle than ordinary nursery plants.

Most of the eucalypts have been planted for ornament or for shade; in a few cases as windbreaks for citrus orchards. It is only recently that any attempt has been made to grow them for commercial purposes. The introduction was often brought about by people from California, or from Australia, who happened to visit Florida, or to

make their home there, who suggested the possibility of growing eucalypts, or planted them themselves. A number of individual trees can be traced to some such source.

In these desultory plantings there was haphazard selection of species and sites, and no care whatever was given the young trees after planting. The frost-sensitive *E. robusta* was planted as far north as St. Augustine in a dry situation on filled-in or "made" land, in spite of the fact that it is a tree which is especially well adapted to low, swampy localities, as its common name "swamp mahogany" indicates; and the extremely frost-sensitive *E. citriodora* was planted as far north as Eustis.

On Mr. Sams's place, Courtenay, Merritts Island, there is a very good windbreak of *E. resinifera*. It consists of more than 200 trees planted in a single row along the side of an orange grove. The trees were about 11 years old at the time of examination, in January, 1910, and measured from 12 to 24 inches in diameter, and from 45 to 65 feet in height. These trees were raised in a seed bed in the open, from seed procured abroad. They seem to be well suited to the locality and are now bearing seed in abundance. Seed from these trees, germinated in a greenhouse at Washington, D. C., showed a high vitality and produced healthy seedlings, which were distributed for planting. (See Pl. I.)

In July, 1909, the Florida East Coast Railway Co. made an experimental plantation of about 3 acres near West Palm Beach, with a view to growing eucalyptus for ties. The species planted were *E. globulus*, *robusta*, *rudis*, and *tereticornis*. They were set out as seedlings when from 8 to 12 inches high, in a low, wet situation, in a fair sandy soil which contained a high percentage of organic matter. Shortly after planting the ground was overflowed to a depth of several inches and remained under water for from six to eight weeks. In January, 1910, all except *E. globulus* were doing well, and measured from 3 to 4 feet in height. The lower 12 or 18 inches of the stems had become lignified. The most damage had apparently been done by wind and the mechanical beating of the rain, since many of the young trees were bent over toward the southwest. The total failure was less than 5 per cent of the original number planted.

St. Augustine is the most northern point at which eucalypts were found. Here there were only a few trees, and these were all of one species, *E. robusta*. All of them have been frequently frozen back and have made slow growth. Even farther south, at Eustis, where many eucalypts had been planted as shade trees, some of the species have been frozen back, notably *E. citriodora;* some species, however, such as *E. robusta*, *rostrata*, and *viminalis*, have not been seriously injured, though few of these antedate the frost of 1895.

The southern limit, so far as ascertained, was Cocoanut Grove, Dade County, on the east coast, and Naples, Lee County, on the west coast, though eucalypts could doubtless be grown to the southern extremity of the State. There are many good specimens along the Gulf shore as far north as Tarpon Springs, as well as in the interior lake region at Avon Park, Seven Oaks, and elsewhere.

SPECIES OF EUCALYPTS NOW GROWING IN FLORIDA.

In all there are now about 16 different species of eucalypts growing in Florida. These are given in Table 3.

TABLE 3.—*Species and locations of eucalypts in Florida.*

Name of species.[1]	Where growing.
1. Eucalyptus citriodora (lemon gum)	Avon Park, Eustis, Indianola, Miami, St. Petersburg.
2 Eucalyptus cornuta (Yate)	Estero, Fort Myers.
3. Eucalyptus crebra (narrow-leaved iron bark)	Avon Park, Miami.
4. Eucalyptus diversicolor (Karri)	City Point.
5. Eucalyptus globulus (blue gum)	Avon Park, Estero, Fort Myers, Tampa, West Palm Beach.
6. Eucalyptus gunnii (cider eucalypt)	Avon Park.
7. Eucalyptus marginata (Jarrah)	Estero, Eustis, Fort Myers.
8. Eucalyptus polyanthema (Australian beech)	Fort Myers.
9. Eucalyptus resinifera (red mahogany)	Courtenay, Fort Myers, Indianola, and Seven Oaks, near Clearwater.
10. Eucalyptus robusta (swamp mahogany)	Avon Park, Bradentown, Daytona, Estero, Eustis, Fort Myers, Miami, Punta Gorda, Seven Oaks, St. Augustine.
11. Eucalyptus rostrata (red gum)	Bradentown, Cocoanut Grove, Estero, Eustis, Fruitville, Fort Myers, Georgiana, Miami, Punta Gorda, Sutherland, Tavares, West Palm Beach.
12. Eucalyptus rudis (flooded gum)	Estero, West Palm Beach.
13. Eucalyptus saligna (New South Wales blue gum)	Fruitville, Miami.
14. Eucalyptus siderophloia (broad-leaved iron bark)	Bradentown.
15. Eucalyptus tereticornis (gray gum)	Avon Park, Estero, Fort Myers, Manatee, St. Petersburg, Tampa, Tavares, West Palm Beach.
16. Eucalyptus viminalis (manna gum)	Avon Park, Eustis, Miami, Tampa.

[1] These have, with a few exceptions, been identified by Mr. George B. Sudworth, Dendrologist of the Forest Service, to whom fresh specimens were sent direct from the field.

EUCALYPTUS CITRIODORA HOOKER (LEMON GUM).

Eucalyptus citriodora has been planted in a number of places, both on the east and west coasts of Florida—at Eustis, Indianola, Merritts Island, Miami, Avon Park, and St. Petersburg. It is not free from frost injury except south of Palm Beach on the east coast and Fort Myers on the Gulf coast. At Eustis and Avon Park all the trees of this species were killed back to the ground by the freeze of 1895. The trees that grew up since sprouted from the stumps of the trees killed back at that time. At St. Petersburg, where the largest specimen has been found, it had at one time been slightly frozen back by a temperature of 20°. A temperature of 23° F., following a warm spell, proved to be injurious to lemon gum.

The nine trees of this species which were measured in Florida gave the following results:

TABLE 4.—*Eucalyptus citriodora in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast-high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*		°*F.*	
Indianola [1]	2	35	6	17.5	3	.....	.....	Sandy.
Miami	4	40	4.4	10	1.	.....	.....	Low pine land.
Avon Park [1]	5	55	10.4	11	2.1	Yes	[2] 23	
Do.[1]	5	30	8	6	1.6	Yes	[2] 23	
Do.[3]	8	60	10	7.5	1.3	Yes	[2] 23	
Indianola [3]	11	40	13	3.6	1.2	.....	.....	Sandy.
Eustis [1]	15	45	8	3	.5	Yes	.....	Fairly good, sandy.
St. Petersburg [3]	18	62	11.4	3.4	.6	.....	20	Poor white sand, deep, no hardpan.
Miami [3]	3	18	2	6	.7	No	.....	Rocky.

[1] Sprout. [2] After 80°. [3] Seedling.

Thus, while these trees were not always grown under the best conditions, some of them showed a growth in height of from 6 to 17 feet a year and from $1\frac{1}{2}$ to 3 inches in diameter. It must be noted, however, that most of these trees, except, perhaps, those grown at Miami, were sprouts, and therefore their growth has been more rapid than trees grown from seedlings.

This species has been found growing on poor, sandy, and rocky soil, but made its best growth on deep, sandy soil with the water table near the surface.

It is one of the most delicate species and requires great care in handling in the nursery, both in the method of seeding and transplanting. A sudden change in temperature when the seedlings are in pots often injures them to an extent that unfits them for transplanting.

The lemon-scented gum is one of the species recommended by Baron von Mueller for tropical climates. It is well adapted to the frostless coast region of Florida, where the temperature rarely falls much below the freezing point and the air is constantly humid. It prefers fresh but not moist soil. Under favorable conditions it makes rapid growth. It flourishes in Portuguese Africa, in Zanzibar, and in northern Brazil (Province of Azaras), where it attained a height of 75 feet and a diameter of 15.3 inches in 12 years.

In the plantations of the Paulista Railway Co., of Brazil, near Sao Paulo, over 1,000 specimens of the lemon-scented gum at 4 years of age attained a height of over 40 feet and a diameter of 7.7 inches.

Those 3 years old attained a height of 33 feet and 5.8 to 6.4 inches in diameter. One specimen 5 years old had a height of nearly 50 feet.

EUCALYPTUS CORNUTA LABILL (YATE).

Eucalyptus cornuta, or Yate, has been found growing in only two places in Florida—Fort Myers and Estero. These, however, are not the only places where *E. cornuta* can be grown. At these places the trees have never been injured by frost, which shows that they are able to withstand temperatures as low as 23° F. They are growing on poor, sandy soils with rock close to the surface, yet their growth, as given in the following table, was very rapid, and in one case reached 10 feet a year.

While no specimens of Yate were found north of Estero and Fort Myers, it may be safely assumed that its range in Florida may be extended somewhat farther north, especially on the west coast. It is a species which is well adapted to a moist climate, such as Florida possesses, but should not be grown in localities where the temperature may fall below 24° F. for any length of time.

This tree will do best on moist soils, especially on rich, moist soils, and will endure much rain, but, as the specimens examined showed, it is fairly drought resistant and makes a fair growth even on poor, sandy soils. In its native home it occurs on limestone soils and will grow in greatly exposed situations.

TABLE 5.—*Eucalyptus cornuta in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast-high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*			
Estero	3	30	5.6	10.0	1.9			Very poor, with rock close to surface.
Do	3	20	4.0	6.7	1.3			Do.
Do	4	30	5.6	7.5	1.4			Do.
Do	4	32	7.7	8.0	1.9			Do.
Fort Myers	4	32	5.6	8.0	1.4			Hardpan.
Do	4	16	4.2	4.0	1.1			Do.
Estero	5	30	5.7	6.0	1.1			Very poor, with rock close to surface.
Do	5	35	8.8	7.0	1.8			Do.
Do	5	38	11.2	7.6	2.2			Do.
Do	5	40	7.7	8.0	1.5			Do.

EUCALYPTUS CREBRA MÜLL (NARROW-LEAVED IRONBARK).

Eucalyptus crebra has been planted at Miami and at Avon Park. In neither of these places was it injured by frost, and it withstood temperatures as low as 20° F. At Miami, where it grows on thin soil

with an underlying limestone which comes very near the surface, it made rather poor growth, but at Avon Park on deep sandy soils it has done well and resisted all the cold weather for the last 10 years, or a minimum temperature of about 20° F.

TABLE 6.—*Eucalyptus crebra in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast-high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*			
Miami	3	25	7.0	6.3	1.8			Low pine land, rock near surface.
Subtropical Garden, Miami.	6	20	4.5	3.3	.7			Thin layer of soil.
Do	6	25	4.0	4.1	.7			Limestone.
Avon Park	8	35	12.6	3.0	1.3	No		Sandy, deep.
Do	8	35	17.0	3.5	1.7	No		Do.
Do	8	30	10.5	3.0	1.1	No		Do.

Its occurrence at Miami and at Avon Park shows that *E. crebra* is adapted to a fairly wide range of climatic conditions. It may be possible that on suitable soils this species can be grown through the central lake region, probably as far north as Eustis, since it has been reported to withstand temperatures as low as 18°. For the present, however, it may not be advisable to extend its range beyond the localities where the temperature is apt to fall below 20° for any long period of time.

The narrow-leaved ironbark is a tree of moderate size. It reaches a height of about 90 feet and a maximum diameter of about 3 feet. Its growth is most rapid during the first few years and becomes slower as the tree grows older. In Brazil, in plantations of the Paulista Railroad, trees of this species attained in five years a height of 25 feet and a diameter of about 3 inches. Trees 2 years old have a height of 4 feet. It grows on very poor soils, provided they are not moist or damp, but it can not withstand water in the ground.

EUCALYPTUS GLOBULUS LABILL (BLUE GUM).

Blue gum, possibly the best known species of eucalyptus, has been extensively planted in southern California and in practically every country into which eucalyptus has been introduced. As a matter of fact, for 20 years it was the only species which was generally planted throughout the world, yet in Florida the blue gum has so far met with little success, though it was one of the first species tried. This failure may be traced in many cases directly to its being planted outside of its climatic range. It is a tree which, for the first year, is especially sensitive to frost. Seedlings can scarcely endure tem-

peratures of 27°. At Fort Myers and Tampa they have been killed back by temperatures of 26°. This extreme sensitiveness to frost when young limits the species to a comparatively small area south of Fort Myers, unless young seedlings can be protected for a year or unless they are set out early in the spring, which will enable them to become sufficiently hardy by the next winter.

Estero was the only place where blue gum was found in flourishing condition and unaffected by temperatures as low as 26°. There several specimens have grown as much as 9 feet a year during the first three years, and made a diameter growth of more than 1 inch a year on very poor soil, with rock close to the surface.

Before any definite conclusion can be made with regard to the growing of blue gum in Florida further planting is necessary within its climatic range. While the tree can grow in a variety of soils, except calcareous and brackish soils, experiences in Brazil and elsewhere have shown that it does best on deep, fresh soils.

The most common complaint against blue gum in Florida is that it does not take root well and is frequently toppled over by the wind on account of its poorly developed root system. Eight specimens were measured, though a much larger number of trees were found growing throughout Florida.

TABLE 7.—*Eucalyptus globulus in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast-high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*		°*F.*	
Estero	3	27	3.9	9.0	1.3	.....	26	Very poor soil with rock close to surface.
Do	3	28	3.0	9.3	1.0	.....	.....	Do.
Avon Park[1]	3	35	6.1	8.8	1.5	Yes	.....	
Estero	4	30	4.7	7.5	1.2	.....	.....	Do.
Do	5	25	4.8	5.0	1.0	.....	.....	Do.
Fort Myers	6	22	3.0	3.7	.5	Yes	26	
Do	6	22	4.5	3.7	.8	Yes	26	
Tampa	22	37	10.5	1.7	.5	Yes	.....	
West Palm Beach.[2]	.....	.....	.....	.....	.....	.....	.....	Sandy.

[1] Sprout. [2] Seedling.

EUCALYPTUS GUNNII HOOKER (CIDER EUCALYPT).

Only one specimen of the cider eucalypt was found, and this was at Avon Park. It withstood a temperature of 22° without the least injury. It is planted on deep, sandy soil, and during the nine years made an average height growth of about 7 feet a year. This species can probably be planted as far north as Eustis, since it has proved to be frost-hardy in many other places where it has been grown. Thus, at Canterbury, New Zealand, this species has been grown success-

fully, though the temperature there frequently falls as low as 20° F. According to Sahut it is a species well adapted to dry situations.

TABLE 8.—*Eucalyptus gunnii in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Minimum temperature.	Soil.
				Height.	Diameter breast-high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*		*° F.*	
Avon Park.....	9	62	22.4	6.9	2.5	No.....	20–22	Sand, 15 to 20 feet deep.

EUCALYPTUS MARGINATA SMITH (JARRAH).

Only three specimens of Jarrah were found in Florida. These were at Eustis, Fort Myers, and Estero. At Eustis the specimen was killed back by frost, which shows that it is not frost-resistant. The stump, however, has thrown out sprouts which make a good growth. At Estero and Fort Myers the trees apparently did not suffer from frost. No specimens were found in the intervening areas between Eustis and Fort Myers and Estero, and therefore the northern limit of the species in Florida can not be determined with certainty. It is safe, however, to assume that this species is adapted only to those portions of Florida where the temperature rarely falls below 24° or 25° F. for any continuous period, since it is chiefly a tree of the Tropics, and in its native habitat the minimum temperature does not fall below 27° F. (See Pl. II, fig. 1.)

Its planting in Florida is of especial interest, since nowhere in the United States has it so far given any satisfactory results. It is possible that this tree may find a more congenial home in Florida than in the Southwest, where the climate is more arid. It should not be planted in dry soils, but in fresh or even moist soils, provided they are well drained.

TABLE 9.—*Eucalyptus marginata in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast-high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*			
Estero.....	3	8	1.5	2.7	0.5	No.....	.....	Very poor, with rocks close to surface.
Fort Myers.....	(?) 13	54	8.3	4.2	.6	No.....	.....	Hardpan.
Eustis.....	.....	42	8.0	.....	.....	Yes, but not recently.	.....	Sandy, good.

EUCALYPTUS POLYANTHEMA SCHAUER (AUSTRALIAN BEECH).

Only one specimen was identified as *Eucalyptus polyanthema*, and this was a small tree about 4 years old on Mr. Thomas A. Edison's place at Fort Myers. It was planted in poor gray sand over hardpan and was not doing well. In California and Arizona it has proved one of the most resistant trees to extremes of both cold and heat, and it can probably be grown in all portions of southern Florida, even as far north as Eustis.

EUCALYPTUS RESINIFERA SMITH (RED MAHOGANY).

The red or forest mahogany was found at four places—Indianola, Courtenay, on Merritts Island, Fort Myers, and Seven Oaks.

It has proved exceptionally resistant to frost, having withstood temperatures of 19° without damage. The largest specimen of this species, and next to the largest eucalyptus tree in the State, was at Seven Oaks. It was planted in 1892, and in January, 1910, measured 39.3 inches in diameter breast-high and 80 feet in height. The bole forks at about 8 feet from the ground into three stout branches. It is growing on poor, deep, white sand, with the water table at about 8 feet from the surface. *Eucalyptus resinifera* is a tree of rapid growth, depending very little on the nature of the soil in which it is planted, and very resistant to drought.

Seven trees were measured, though at Courtenay alone there must be nearly 200 trees. (See Pl. I.)

TABLE 10.—*Eucalyptus resinifera in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast-high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*		° *F.*	
Indianola	4	18	2.0	4.5	0.5	No	25–26	Hummock land.
Fort Myers [1]	4	[2] 22	5.0	5.5	1.3			Hardpan.
Do	5	24	3.4	4.8	.7			Do.
Indianola	14	85	30.0	6.1	2.1	No	18	Poor sand.
Do	14	80	34.0	5.7	2.4			
Courtenay [3]	11	60	18.0	5.5	1.6			Poor, sandy.
Seven Oaks	18	80	39.3	4.4	2.2	No		Poor sand, white, no hardpan.

[1] Sprout. [2] Topped. [3] One of the largest of 200 trees—a seedling.

So far as can be ascertained from the data at hand, this species seems to be preeminently the tree for planting practically throughout the whole of the orange belt of Florida—from Merritts Island on the east and Tampa on the west and south. Experiments in Por-

tugal, Italy, and Spain and in the southwestern United States have shown that it can endure frosts of 23°, 21.2°, and 19.4° F., without danger, when they come singly, but not when they come near together or last long.

It will grow on a great variety of soils—clayey, chalky, stony, limestone, granite, sandy, dry, fresh, or moist. It does well on exposed situations, because the branches are not easily broken. One situation which it can not stand, however, is a swamp with stagnant water. It grows most rapidly, of course, on fertile soils, light and moist, but it adapts itself very well to poor soils, and even to arid soils. In Australia it is most abundant on hard, close-packed hillocks, on gravel, and on sandy beaches. In Chile, where this species has been grown with great success, it made the following growth on moderately good and well-watered soils:

TABLE 11.—*Eucalyptus resinifera in Chile.*

Age.	Height.	Diameter.
Years.	*Feet.*	*Inches.*
5	23– 33	3.1– 3.0
10	56– 66	7.8– 9.8
15	98–115	17.5–19.5
20	115–125	25.4–27.3

EUCALYPTUS ROBUSTA SMITH (SWAMP MAHOGANY).

The swamp mahogany was found in more places than any other species except *Eucalyptus rostrata*. From St. Augustine to Miami and from Eustis to Estero it has been planted as a shade tree, for which purpose its pleasing, symmetrical form, spreading habit, and large, showy flowers make it exceptionally suitable.

At St. Augustine, Eustis, and Daytona these trees have been killed back by frost at temperatures of 23° and lower, but, as is usual with most species of this genus, even if frozen down to the ground it recovers and sends up sprouts which make rapid growth. The swamp mahogany must, however, be classed with species very sensitive to frost, and can be safely planted only where the temperature never falls below 25° or 24° F. The largest tree measured was at Punta Gorda, where a specimen 24.3 inches in diameter and 55 feet in height was said to be 15 years old. At Fort Myers, especially during the first years, this species showed a remarkably rapid growth, and in some cases it amounted to from 10 to 14.5 feet a year. A number of the trees, scarcely 3 years old, bore flowers in profusion. Farther north, where the climatic conditions were less favorable to it, the trees often did not grow more than 2 feet a year.

TABLE 12.—*Eucalyptus robusta in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast-high			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*		°F.	
Fort Myers	1⅛	17	3.0	14.5	2.6	No		Poorest land, gray sand, hardpan 6 inches thick.
Do	1⅛	17	3.0	14.5	2.6			Do.
Do	2¼	23	3.0	10.2	1.3			Hardpan at varying depths from surface.
Do	2¼	23	4.0	10.2	1.8			Do.
Daytona[1]	3	18	3.0	6.0	1.0	Yes	18	
Do.[1]	3	15	2.0	5.0	.7	Yes	18	
Estero	5	25	5.1	5.0	1.0	No		Very poor with rock close to surface.
Do	5	28	5.8	5.6	1.2			Do.
Avon Park[1]	5	23	8.8	4.6	1.8	Yes	23	
Miami	7	30	10.0	4.3	1.4			Low pine land, rock close to surface.
St. Augustine[1]	13	40	8.4	3.1	.6	Yes	14	
Do.[1]	13	37	9.5	2.8	.7			
Do.[1]	13	25	8.3	1.9	.6			
Bradentown	(?) 13	32	11.5	2.5	.9		28	Hardpan 6 inches thick, 3 feet from surface.
Fort Myers	13	65	17.8	5.0	1.4			Hardpan at varying depths from surface.
Punta Gorda	13	50	19.6	3.8	1.5	Yes		Sandy.
Do	14	55	24.3	3.9	1.7	No		Do.
Do	14	48	17.0	3.4	1.2	No		Do.
Do	14	50	19.6	3.6	1.4	No		Do.
Do	14	60	16.6	4.3	1.2	No		Do.
Do	14	40	12.7	2.9	.9	No		Do.
Do	14	42	11.7	3.0	.8	No		Do.
Do	14	52	16.3	3.7	1.2			Do.
Seven Oaks[1]	20	53	15.9	3.5	1.1	Yes	22	
St. Augustine[1]		25	7.9					
Eustis[1]		45	21.0			Yes		
Punta Gorda		35	8.0			No		Do.
Miami Subtropical Gardens.		25	6.0					Thin layer of soil; rocky limestone.

[1] Sprout.

It was found growing on a variety of soils, ranging from gray sand underlaid with hardpan to rocky limestone. None of the specimens examined have been planted in soil suitable to the species, and many entirely outside of its climatic range. The measurements therefore give only an approximate idea of what the species can do under suitable conditions. (See Pl. II, fig. 2, and Pl. V.)

In the plantations of the Paulista Railroad Co., in Brazil, trees of this species attained in three years a height of 33 feet and 6.4 inches in diameter; trees 4 years old, planted when only 12 inches high, had a height of from 52 to 56 feet and a diameter of 9.5 inches.

While it grows on a variety of soils, it prefers low, wet situations, and does not do so well in deep, dry sand or where there is a hardpan

close to the surface. It may be recommended for planting in places where there is an abundance of moisture in the soil and in warm, swampy localities. In can be grown very near the sea in marshy soil, and even on slightly brackish tracts, since the salt does not seem to be detrimental; but here it is subjected to windbreakage during heavy storms. It is very free from insect damage.

EUCALYPTUS ROSTRATA SCHLECHT (RED GUM).

The red gum is found at more places and in larger numbers than any other species in Florida; from Eustis, in the central part of the State, south along the east coast to Cocoanut Grove, and on the west coast from Estero up as far north as Sutherland. The largest eucalyptus tree in the State is a red gum. It is growing near Fruitville, and is now 24 years old and measures 80 feet in height and 49 inches in diameter breast-high.

The only places where this species suffered from frost were Eustis and Tavares. At both places the injury occurred when the trees were 1 or 2 years old. At Tavares the seedling had been frozen back by a temperature of 19° immediately following a warm spell in 1895, but when cut to the ground it at once sprouted vigorously, and is now 70 feet high and 21.1 inches in diameter breast-high. At Eustis this tree was killed back when 1 year old by a somewhat lower temperature. This would indicate that trees of this species after they have passed the juvenile stage are fairly resistant to temperature as low as 18° or 19° F.

Trees at Punta Gorda have withstood, without any injury, temperatures of 22° and made an average growth of a little over 4.5 feet in height and 1.5 inches in diameter a year. They have withstood also the gales to which they are exposed, some of them being planted within 100 yards of the seacoast. (See Pl. V.)

The trees were growing on a variety of soils—on poor sand, with hardpan or rock close to the surface, on limestone, and in one case at Estero on low ground subject to inundation. Since this species prefers low, humid situations, with a stiff but not impermeable soil, and grows well when inundated periodically, even where the water is somewhat brackish, the soils in which it was found growing in Florida were the least suitable to it. The growth which it made on those soils indicates, however, as experiments in France and Algeria also have shown, that it can grow well in dry situations. The frost hardiness of this species, its adaptability to moist soils, and the excellent quality of its wood, make it particularly worth considering for planting on the large stretches of low-lying wet lands of Florida.

It has now been sufficiently tried in Florida to justify planting it in localities where the temperature does not fall, for any long period,

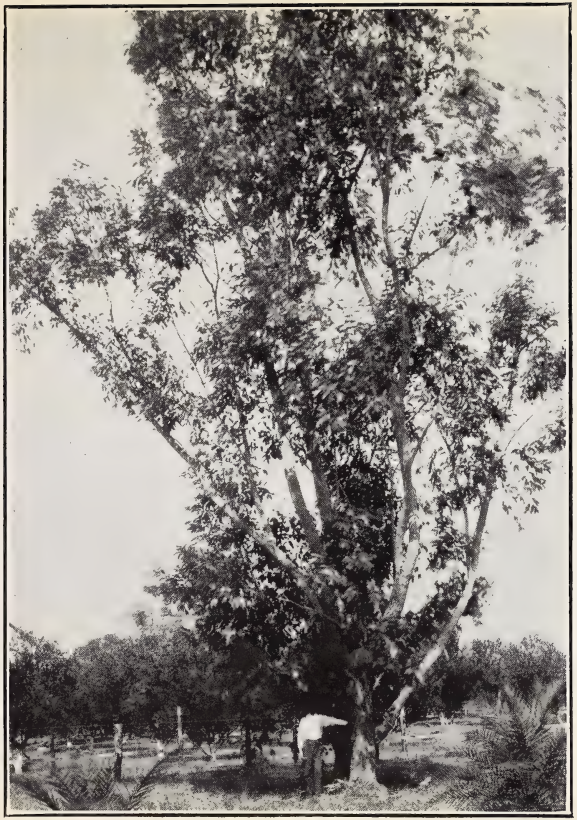


Fig. 1.—Twenty-year-old Swamp Mahogany (Eucalyptus robusta). Sprouts from Stump of Tree Killed Back by Frost. Diameter, 15.9 Inches; Height, 53 Feet. Seven Oaks, near Clearwater.

Fig. 2.—Sprouts of Swamp Mahogany (Eucalyptus robusta) from Stumps of Trees Killed Back by Frost. Largest Sprout 21 Inches in Diameter, 45 Feet High. Eustis.

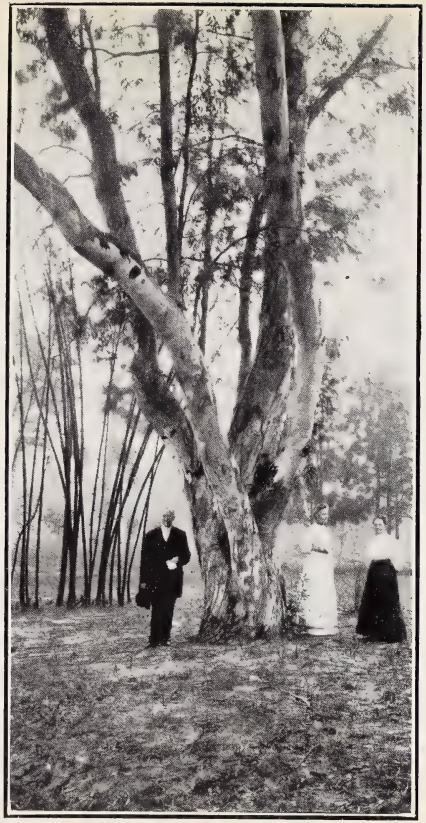


FIG. 1.—TWENTY-YEAR-OLD RED GUM (EUCALYPTUS ROSTRATA). DIAMETER, 44.8 INCHES AT 2 FEET FROM GROUND; HEIGHT, 83 FEET. CAMPUS OF SOUTHERN COLLEGE. SUTHERLAND.

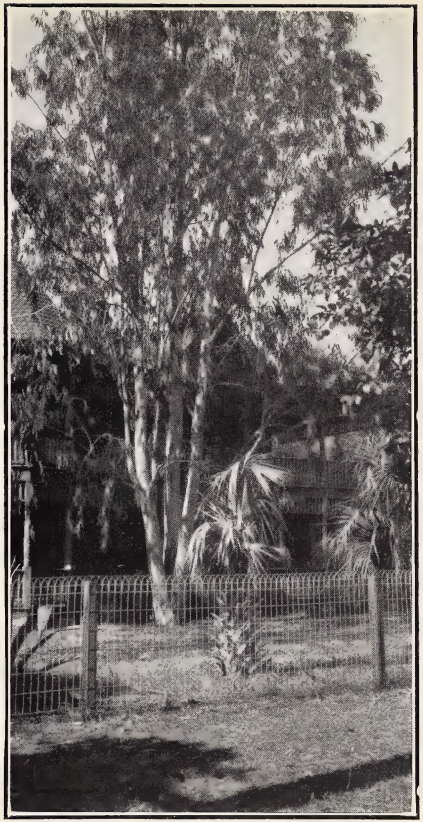


FIG. 2.—SIXTEEN-YEAR-OLD RED GUM (EUCALYPTUS ROSTRATA). SPROUTS FROM STUMP OF TREE KILLED BACK BY FROST. DIAMETER, 16.5 INCHES; HEIGHT, 55 FEET. EUSTIS.

below 22° F., and with proper protection of the seedlings even where the temperature falls as low as 20° F.

TABLE 13.—*Eucalyptus rostrata in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast-high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*		°*F.*	
Fort Myers	4	22	1.9	5.5	0.5			Hardpan.
Estero	4	32	2.5	8.0	.6			Very poor, with rocks close to surface.
Do	4	20	2.2	5.0	.6			Do.
Do	4	23	3.1	5.8	.8			Do.
Do	4	32	7.0	8.0	1.8			Do.
Tavares[1]	4½	45	9.9	10.0	2.2	No		
Fort Myers	5	10	2.0	2.0	.4			Hardpan.
Do	6	50	8.5	8.3	1.4			Hardpan, 2 feet from surface.
Do	6	35	7.0	5.8	1.1			Do.
Do	6	40	10.0	6.7	1.7			Do.
Cocoanut Grove	9	35	3.0	3.9	.3			Thin layer of soil; rocky-like limestone.
Bradentown	12	70	25.8	5.8	2.2			Hardpan, 2 feet thick, 6 feet from surface.
Do	12	78	23.8	6.5	2.0	No	28	Hard yellow sand, 10 feet from surface.
Do	12	57	14.2	4.8	1.2			Do.
Do	12	63	22.4	5.3	1.9			
Fort Myers	13	72	19.0	5.5	1.5			Hardpan.
Estero[2]	15	80	21.6	5.3	1.4	Yes	14	Limestone shell rock 0′–8′, broken up.
Tavares[2]	15	70	21.1	4.7	1.4	Yes	[3] 19	Good hummock land, hardpan.
Do.[2]	15	65	16.1	4.3	1.1	Yes		
Estero	15	65	16.5	4.3	1.1	Yes	14	Very poor, with rock close to surface.
Do	15	65	17.5	4.3	1.2	Yes		Do.
Eustis	16	55	16.5	3.4	1.0	Yes		
Punta Gorda	16	75	23.8	4.7	1.5		22 or 23	Hardpan, 2 feet from surface.
Sutherland	20	83	[4] 44.8	4.2	2.2			
Fruitville	24	80	49.0	3.3	2.0	Yes	20	
Georgiana	32	[5] 40	24.0	[5] 1.3	.8			
West Palm Beach.[6]								Sandy.
Do.[6]								Do.
Miami Cemetery.		35	8.4					High pine land.
Miami		18						
Do.[6]		40	8 or 9					
Subtropical Gardens, Miami.		30	6 to 7					Thin layer of soil; rocky-like limestone.

[1] Transplanted sucker.
[2] Sprout.
[3] After warm spell.
[4] Two feet from ground.
[5] Probably taller. Height growth very short for diameter.
[6] Seedling.

EUCALYPTUS RUDIS ENDL. (FLOODED GUM).

The flooded gum is one of the species planted at the experimental plantation of the Florida East Coast Railway Co., at West Palm

Beach. While it is too young here to draw any conclusions, yet it has withstood the long inundation to which it was subjected soon after planting and is now from 3 to 4 feet high and in vigorous condition.

The only other locality where this tree was found was at the Koreshan community, at Estero, where trees of this species 5 years old are growing on very poor, sandy soil with the underlying rock close to the surface. They have averaged 1.8 inches in diameter growth per annum. Three trees measured give the following results:

TABLE 14.—*Eucalyptus rudis in Florida.*

Age.	Height.	Diameter breast-high.	Average annual growth.	
			Height.	Diameter breast-high.
Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*
5	42	8.7	8.4	1.7
5	40	9.3	8.0	1.9
5	38	8.6	7.6	1.7

Here the temperature seldom, if ever, falls as low as 24° F., and they have never been injured. However, the fact that in the Southwest it has been one of the most resistant when exposed to great variations of heat and cold, from a maximum of 110° to 118° to a minimum of 15° to 18° F., shows that the planting range in Florida may be safely extended farther north.

It may be planted on low, wet lands, which are subject to inundation, as far north as Eustis and throughout the whole southern part of the State. In Australia it makes its best growth on low flats around swamps and along the banks of streams. It is not a very tall tree, seldom exceeding 80 feet in height, and is apt to be irregular and sometimes even drooping in form.

EUCALYPTUS SALIGNA SMITH (NEW SOUTH WALES BLUE GUM).

Only two specimens were identified as *Eucalyptus saligna*. One of these was a tree 23.4 inches in diameter and 73 feet in height, said to be about 25 years old. It was growing at Fruitville on yellow sand such as is frequently chosen for orange groves, and there was an impermeable stratum some 12 feet from the surface. This tree had withstood temperatures of 22° F., and had never been seriously injured.

The other specimen was a small seedling at Miami, about 8 inches in diameter and 25 feet in height. This tree has been planted in an exposed situation and is bent and dwarfed by the wind.

In its native home in New South Wales this species attains a height of 100 feet and a diameter of 6.5 feet. It prefers deep soil in warm coast regions and in the vicinity of rivers, and will not endure drought well.

It is suitable for planting near Fort Myers and Miami and also in the Everglades region, particularly on low, wet, sandy soils. When planted close, it produces lofty, straight stems, but when isolated it is apt to take a low, branchy form.

TABLE 15.—*Eucalyptus saligna in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast-high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*		*°F.*	
Fruitville [1]	(?)25	73	23.4	2.9	0.9	No	22	Hardpan 12 feet from surface; orange land yellow.
Miami [2]		25	8.0					

[1] Sprout. [2] Seedling.

EUCALYPTUS SIDEROPHLOIA BENTHAM (BROAD-LEAVED IRON BARK).

Only one specimen of this tree was found. This was planted at Bradentown about 10 years ago, and now measures 13.7 inches in diameter and 55 feet in height. It was in full bloom on February 16. It was never affected by frost, though the temperature must have fallen occasionally as low as 22°. The tree is in a flourishing condition, although it is growing on dry soil.

In California it has been reported to withstand temperatures of 18° to 20° F. Since it was the only tree of this species that was found in Florida, it is not safe to draw any conclusions as to the adaptability of the species to that State.

In its native habitat it is found chiefly in the mountains of New South Wales, where conditions are not at all similar to those in Florida. Under favorable conditions this iron bark reaches a height of 150 feet and a diameter of 4 feet in New South Wales and the southeast districts of Queensland.

TABLE 16.—*Eucalyptus siderophloia in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast-high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*			
Bradentown ...	10	55	13.7	5.5	1.4	.....	.....	

EUCALYPTUS TERETICORNIS SMITH (GRAY GUM).

Gray gum has been planted at quite a number of places, chiefly, however, along the west coast from St. Petersburg to Estero, and through the central lake region from Tavares to Avon Park. It is also being tried in the Florida East Coast Railway Co.'s plantation.

One tree of this species at Avon Park has made the most rapid diameter growth of any eucalyptus measured in Florida, showing in 9 years a total of 25.5 inches in diameter and 60 feet in height, or an average diameter growth of 2.8 inches. This tree is on sandy soil 10 or 15 feet deep, with a stiff subsoil, and has withstood temperatures of 22° without being injured. It has made the best growth on deep, sandy soils, and young trees have even done well on soils underlaid at no great distance by rock or hardpan, and at St. Petersburg it has not been injured by temperatures of 20°, but this same species at Tampa was frozen back at 19° F., although not permanently injured.

It is not particular as to soil, but prefers warm coast regions, and becomes stunted if grown on exposed, rocky situations. In dry, compact soil its development is not satisfactory, but on sandy soil, even though dry, its growth has been quite rapid, as is well demonstrated by the specimen at Avon Park.

It is one of the most beautiful species, with its pyramidal form and straight bole. In its native habitat it is never found far from the coast, preferring low, humid flats around lakes or water courses, but never on saline situations. There it attains a height of from 100 to 160 feet and a diameter of 6.5 feet at the base. The usual rate of growth of this tree is about two-thirds that of blue gum.

In Provence and Algeria it has grown well on low, marshy tracts where the soil is deep, and in Brazil on inundated soil where *E. rostrata* could not be grown successfully. Here some of these trees planted by the Paulista Railway Co. in four years attained a diameter of 7.6 inches and a height of 40 to 50 feet.

In California it is said to endure minimum temperatures of 15° to 20° and to also withstand drought well.

TABLE 17.—*Eucalyptus tereticornis in Florida.*

Location.	Age.	Height.	Diameter breast high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*		° *F.*	
Estero	3	25	4.4	8.3	1.5			Very poor with rocks close to surface.
Fort Myers	4	30	4.3	7.5	1.1			Poor sand, hardpan close to surface.
Estero	4	28	4.4	7.0	1.1			Very poor with rocks close to surface.
Fort Myers	4	20	3.6	5.0	.9			Hardpan at varying depths from the surface.
Do	4	25	4.9	6.3	1.2			Do.
Do	4	30	6.0	7.5	1.5			Do.
Do	6	37	9.0	6.2	1.5			Hardpan.
St. Petersburg	(?) 6	33	11.7	5.5	2.0	No	20	
Do	(?) 6	30	10.3	5.0	1.7	No	20	
Avon Park	6½	32	7.5	4.9	1.2	No		Sandy 10 to 15 feet to clay.
Do	10	20	6.0	2.0	.6			
Do	10	32	9.4	3.2	.9			
Do	9	60	25.5	6.7	2.8	No	22	Sandy, 15 or 20 feet deep.
Tampa[1]	14	48	10.2	3.4	.7			
Tavares[1]	15	36	8.2	2.4	.5	No		
Manatee	25	77	33.1	3.1	1.3			
Tampa	(?) 25	70	22.8	2.8	.9			
West Palm Beach.[1]								Sandy.
St. Petersburg		22	4–6				20	Hardpan 4 feet from ground.
Avon Park		35	6.5					Sandy 10 to 15 feet to clay.

[1] Seedling.

EUCALYPTUS VIMINALIS LABILLIARDIERE (MANNA GUM).

Manna gum was found at four places in Florida, and only at the most northern location, Eustis, had it ever been affected by frost. There a temperature of 16° F. caused the withering of some of the branches, but the injury was not severe. At none of the other places where it was found—Tampa, Miami, and Avon Park—was it ever injured by frost. At Avon Park it was planted on deep, sandy soil and made its best growth there. One specimen there 15 years old had a height of 57 feet and a diameter of 26.8 inches at breast-height. Of all the eucalypts tried in Florida, the manna gum has proved so far the hardiest species. It can safely be planted within the orange range of the State.

In Canterbury, New Zealand, it withstood temperatures as low as 20°. It has been grown even at Haddington, in southern Scotland. There it withstood for 30 years the winters in the open air, and has attained a diameter of 8 feet at the base and a height of 50 feet, though it was sheltered from cold winds.

In Florida it was found growing chiefly in dry situations, which are not the most favorable places for its development. Felix Sahut [1] classes the manna gum with species which prefer moist and even swampy situations. For the same reason Naudin recommends the species for planting on the seacoast and for the *landes* of Brittany and Bordeaux.

Manna gum varies in growth according to the character of the soil. Thus in Brazil, in the plantations of the Paulista Railroad Co., trees 4 years old varied in height from 13 to 69 feet, though the majority of the trees approached the latter height.

In Florida the species may be recommended as a suitable tree for protection of citrus orchards and for decorative purposes.

TABLE 18.—*Eucalyptus viminalis in Florida.*

Location.	Age.	Height.	Diameter breast-high.	Average annual growth.		Killed back by frost.	Temperature.	Soil.
				Height.	Diameter breast-high.			
	Years.	*Feet.*	*Inches.*	*Feet.*	*Inches.*			
Avon Park [1]	12	40	21.0	3.3	1.8	No		Sandy, 15 feet deep.
Do	15	38	20.0	2.5	1.3			
Do [1]	15	57	26.8	3.8	1.8			
Eustis	20	75	30.0	3.8	1.5	Yes		
Tampa	25	69	23.0	2.8	.9	No		
Do	26	52	18.2	2.1	.7			
Miami [1]		40	9.5					

[1] Seedling.

SPECIES SUITABLE FOR VARIOUS SITES.

Within their climatic range, the species now growing in Florida may be further divided as to their soil and moisture requirements, as follows:

Where the water is fresh:
- On moist or wet lands—
  - E. cornuta.
  - E. robusta.
  - E. rostrata.
  - E. rudis.
  - E. saligna.
  - E. viminalis.
- On fresh soils—
  - E. citriodora.
  - E. globulus.
  - E. marginata.
  - E. polyanthema.
  - E. resinifera.
  - E. siderophloia.
  - E. tereticornis.

Where the water is fresh—Continued.
- On dry soils—
  - E. crebra.
  - E. gunnii.
- On limestone soils—
  - E. cornuta.
  - E. resinifera.

Where the water is slightly brackish:
- On moist or wet lands—
  - E. robusta.
  - E. rostrata.
  - E. viminalis.

[1] "Les Eucalyptus."

FEASIBILITY OF COMMERCIAL PLANTING UNDETERMINED.

Some species of eucalypts are undoubtedly adapted to the climatic conditions of the southern part of Florida. This adaptability is well shown in the large sizes which the trees attain within a comparatively short time, their comparative freedom from frost injury, and the relative ease of propagation. The species which appear especially well adapted to the climate of Florida, as far as the observed specimens indicate, are *E. resinifera*, *rostrata*, *viminalis*, *robusta*, and *tereticornis*. It would be unsafe, however, on the basis of the individual trees examined—and most of the eucalypts planted in Florida are either single trees or single rows planted as windbreaks—to make definite recommendations as to the advisability of planting these species on a commercial scale for the production of saw timber, ties, poles, or similar products, because the rate of growth in commercial plantations would probably not be so rapid as that of open-grown trees. A tree may be a success as a shade tree or in a windbreak, yet the expense connected with growing the trees, their form when grown in a new region, and the impossibility of foretelling market demands, may make them of doubtful value for commercial planting. The advisability of planting eucalypts on a large scale for commercial purposes can be determined only after the methods and costs of planting have been ascertained by trial. The facts thus far obtained prove only that portions of Florida are climatically suitable for growing certain species of eucalypts. What is needed next is to determine what are the best methods of planting and growing eucalypts, how cheaply such plantations can be made, and what may be the returns on various soils. To ascertain these facts, species must be planted, not as single trees or even as windbreaks, but as forest stands several acres in extent, by different methods of planting, and with different methods of cultivation.

Other species which were found in Florida, such as *E. citriodora*, *globulus*, and *marginata*, may prove suitable to the climatic and soil conditions of certain sections of Florida, but they have not yet been planted in sufficient numbers, even as single trees, to justify definite conclusions as to their possible future usefulness. Still more uncertain are such species as *E. saligna*, *siderophloia*, *cornuta*, *gunnii*, and *polyanthema*. There are very few trees of these species in Florida, and since most of these trees have not yet reached the seed-bearing stage their botanical identity could not be completely established. No judgment can be formed as to the suitability of these species until more of them have been planted and tried.

On the whole, the planting of eucalypts in Florida is still in the experimental stage; it has not yet reached a point where it can be

taken up commercially and developed on a large scale. The sooner the unsystematic introduction of eucalyptus is replaced by systematic and definitely planned experiments, the sooner will the planting of eucalypts in Florida be placed on a solid foundation.

Again, the commercial planting of eucalypts in Florida is radically different from what it is in southern California. In California, until recently, eucalypts have been grown chiefly to supply the demand for fuel wood, which, in a country where hardwood trees are scarce, brings a good price. In Florida there is no present demand for the introduction of a new tree for fuel wood. It is doubtful whether wood grown in plantations could compete in price with the abundant supply of native timber. The sole inducement for growing eucalypts on a commercial scale would therefore be to produce ties, poles, piles, saw timber, and posts, which the native species can not produce as quickly and cheaply. But to furnish such products plantations would have to be allowed to grow for a longer time than is usual with the eucalyptus groves planted for cordwood; and the longer the period during which the trees must be grown before they can be cut the greater is the danger from severe frosts. The financial loss from a freeze in Florida may, therefore, be much greater than in California, where small-sized timber can be marketed.

Disregarding the risk of freezing, and assuming that the species planted would do as well in Florida as in Brazil or California, the wood of eucalyptus would be entirely new on the market, and might not find a ready sale on account either of its weight, the difficulty in handling and seasoning it, or the consumer's lack of knowledge of its qualities. The reputation of eucalyptus wood is based chiefly on the wood obtained from mature timber of some such species as Jarrah and Karri, imported from Australia, which unquestionably furnishes a high grade of hardwood for lumber and structural purposes and brings a high price in the market. But the trees from which this wood is obtained are from 200 to 400 years old. Whether the eucalyptus trees grown in Florida would yield valuable wood if cut when still very young is a question which can be determined by actual experiment. There are many instances of woods which enjoy a high reputation when grown under natural conditions in their native home, but when produced under different conditions in a foreign country are difficult to market. One of the most striking examples is white pine (*Pinus strobus*). The lumber from American-grown large virgin timber had earned a very high reputation in Germany and Austria, so this pine has been extensively cultivated abroad; but when managed on a short rotation, as most of the forests are managed abroad, it produced only sapwood. With this treatment it

has proved inferior to the native Scotch pine, and is not readily taken by lumbermen or wood users.

On the other hand, if the species which may be well adapted to Florida can be economically planted and grown on a large commercial scale, and will yield durable ties, posts, and piles at an age at which the native species hardly reach sapling size, they will prove of the greatest economic value to the State. There are large areas in Dade, De Soto, Lee, Hillsboro, Pasco, Hernando, and Sumter Counties which at present are not in a high state of productivity, but could be made to add to the forest wealth of the State if thorough experiments prove that eucalyptus growing on them would be economically successful. The eucalypts would also form most efficient windbreaks, which, if properly arranged, would be of great benefit to the citrus interests of the State.

METHODS OF PLANTING MOST SUITED TO FLORIDA CONDITIONS.

A discussion of methods of planting eucalyptus in Florida must necessarily take the form of general suggestions, rather than of exact directions based on actual experience. Owing to the different conditions of climate, topography, and soil, the time and the methods of planting must deviate in many essentials from those in southern California. One phase of the planting operations, however, namely, the raising of seedlings from seed, has been highly developed in California and can be followed to advantage in nearly every particular in Florida. Detailed description of this work may be found in several publications of the State forester of California.[1] A brief summary of the essential points will suffice in this place.

RAISING OF SEEDLINGS.

Eucalyptus is usually propagated by means of seed, but inasmuch as the seed is very small and is too expensive for broadcast sowing, even if this were otherwise feasible, seedling stock grown in flats is mainly used.

The delicate eucalyptus seedlings can not be safely transported for long distances. If satisfactory stock is to be obtained, it must therefore be grown in Florida either by the prospective planter or by nurserymen who know how to handle it. With eucalyptus stock raised in the same manner and sold at the same price as horticultural stock the profitable commercial planting of eucalyptus is not pos-

[1] Circular 2, California State Board of Forestry, "A Handbook for Eucalyptus Planters;" Bulletin 196, California Agricultural Experiment Station, "Eucalyptus in California."

sible. The season of propagation is different from that of horticultural stock, and the seedlings grow so fast that unless they are disposed of within about six months they become too large to be handled economically and are a dead loss, except for the few that may be sold singly or by the dozen for ornamental planting. For commercial planting they must be had by the thousand, since about one thousand trees are required to plant one acre.

When only a few trees are to be planted, it is cheaper to buy nursery stock, but for large plantations it is always cheaper and usually more desirable to raise the seedlings. Few nurseries are prepared to fill large orders for a particular species, and prohibitive prices are asked.

The seedlings may be grown in the open in Florida, if in a protected place. Seed beds should be protected from birds and animals by means of three-fourths inch mesh wire netting around all sides and over the top of the beds. For regulating the light and moisture conditions screens made with a framework of lath and covered with coarse cotton cloth or with lath spaced a lath's width will be most useful. These may be easily and cheaply constructed and have the advantage of being light and easily handled. When there is too much light and the young seedlings are apt to dry out the screens should be laid over the beds, but on damp, cloudy days they should be removed so as to give free circulation of air and lessen the liability to "damping off."

For raising seedlings on a larger scale, however, a lath house that affords protection from frosts in winter and from excessive sunlight in summer, as well as from birds and animals, is an advantage. In southern California it has been found that the best sort of lath house is constructed of a framework of 2 by 4 inch scantlings securely fastened to corner posts. The laths are spaced the width of a lath apart and nailed on this framework diagonally. The lath house is high enough to allow the workmen to stand erect in it, and has a door at each end wide enough to admit a wheelbarrow. A structure of this sort 30 by 70 feet is large enough for 50,000 seedlings, and one 60 by 60 feet will shelter about 100,000 seedlings, with ample room for paths.

The best soil for seedlings is a sandy loam consisting of two parts of leaf mold and one part of coarse sand. Shallow boxes, called flats, which are constructed of half-inch boards, preferably heart cypress, in rectangular shape about 24 inches long, 78 inches wide, and 4 inches deep are used as a seed bed. They have enough small holes in the bottom to allow free drainage, and are filled to within half an inch of the top with the finely pulverized soil previously prepared,

and the seed is distributed broadcast in an even and uniform layer and covered lightly with pure sand to a depth of not more than one-fourth of an inch. After this the flats are kept moist, but not wet, and partly shaded, till germination takes place, which usually is in from one to two weeks from the time of sowing the seed.

The most critical time is just after the seedlings have germinated. At this period they require great care and particular attention to the amount of water given them, because they are apt to be attacked by a fungous disease known as "damping off." Conditions favorable to this disease are produced by an excess of moisture and lack of a free circulation of air. On the other hand, lack of sufficient moisture will cause them to dry out and wither. In either case the young plants die. The rule is to keep the plants moist, but not wet; to water often, but sparingly.

After the seedlings have reached a size of from 2 to 4 inches they are transplanted to other flats with a little stiffer soil, in regular rows about 2 inches apart each way or, preferably, in paper pots. In the former case there will be 108 plants to each flat; in the latter case if 3-inch pots are used, only 48 plants to each flat. Having the plants in the flats or pots makes handling much easier, both in the nursery and in field planting, and also facilitates the counting of the stock. The transplanting into flats or pots is best done on a rainy or cloudy day, for the roots of the young seedlings are very delicate and are killed if they become dry. After being thus transplanted the plants are kept from drying out by shading for a few days.

In from four to six months from the time the seed is sown the trees attain a height of from 5 to 20 inches, and are ready to be set in their permanent places in the field. About 12 inches is a good size for planting. If the seedlings are kept in the flats too long the roots become pot-bound and growth is interfered with. The flats must always be kept well weeded.

In California, if the planting site is dry, the plants are hardened by being gradually accustomed to more sun and air and less water. In Florida this will probably be unnecessary in most cases. Transplants should always be thoroughly watered for two or three days just before they are set out in the field.

In order to raise the proper amount of seedlings for a given area it is necessary to know how much seed to buy. There are a great number of eucalyptus seeds to the pound, and the germination percentage of fresh seeds is high.

The figures in the following table, published for the first time, give the number of seeds per ounce of 14 different species, as obtained by count in the Forest Service.

TABLE 19.—*Number of eucalyptus seeds to the ounce.*

Name of species.	Seeds per ounce.	Plants for field planting from 1 ounce of seed.	Name of species.	Seeds per ounce.	Plants for field planting from 1 ounce of seed.
	Number.	*Number.*		*Number.*	*Number.*
E. amygdalina	6,600	1,320	E. microcorys	910	180
E. citriodora	8,484	1,700	E. obliqua	(1)	
E. cornuta	6,120	1,220	E. paniculata	800	160
E. corynocalyx	12,500	2,500	E. robusta	1,908	400
E. diversicolor	1,770	350	E. rostrata	25,000	5,000
E. globulus	4,200	800	E. resinifera	(1)	
E. gunnii	14,130	2,830	E. tereticornis	1,412	280
E. marginata	4,600	920	E. viminalis	15,800	3,160

[1] Seeds indistinguishable from chaff, over 30,000 per ounce.

In small quantities the price of seed varies from 50 cents per ounce for species like *E. globulus* to $2 per ounce for species like *E. citriodora*. On a general average $1 per ounce will be a safe estimate of the cost of the seed.

TIME OF PLANTING.

In California there are distinct wet and dry seasons, and planting is usually done from the end of the winter rainy season, late enough to escape frosts, to June and July.

In Florida, however, the season may be extended under different conditions over nearly all the year, except the three winter months of December, January, and February, in which frosts are most likely to occur.

For planting on dry situations it is best to raise the seedlings under protection in the winter, beginning about September or October, and to do the field planting late in February or early in March, just as soon as the danger from frost is over. This is also best in the case of very frost-sensitive species in order to allow them to have a longer vegetative period, and consequently to be better able to resist the possible low temperature of the following winter.

In the southern part of the peninsula, however, and on situations where there is danger of an overabundance of water during the summer months, and with the species which are least frost sensitive, the seedlings may be grown in the open during the spring and summer months and planted in the field early in the fall, soon after the rainy season is over and as soon as the surplus water in the soil has disappeared. Experience in Florida has shown that the roots are likely to rot because of the heat and excess of water in the ground if the seedlings are planted on wet sites in the summer without giving time for the roots to become well established before the rains begin.

FIELD PLANTING.

Preparation of the planting site.—The first and most essential thing in establishing forest plantations of any kind is the protection of young stock from fire and animals. Unless these can be kept out, it is worse than useless to expend time and money in planting.

It will usually be necessary to inclose the area by means of some sort of fence, to post notices warning against trespass, and to plow lines around the plantation. If the area is large, it should be subdivided into smaller areas or blocks by plowing or burning lines of division.

Experience has proved that it is of great advantage to the plantation if the ground has been previously cultivated and some agricultural crop has been raised on it. Under these conditions more rapid and more uniform growth may be expected. Moreover, the use of the land for an agricultural crop for the first two or three years, even after the eucalypts are planted, brings some return, and thus decreases the cost of the plantation, besides keeping the ground cultivated and clear of weeds. In preparing the ground, machine cultivation is the most economical wherever practicable, and the land should be plowed and harrowed or disked.

Where preliminary cultivation of the ground is impossible because of roots or stumps, or inadvisable because of labor conditions, the pit method of planting should be adopted. The holes should be about 20 inches square and deep enough to accommodate the longest roots. They can be made with a spade or mattock. The top soil is used first to cover up the roots. On stiff or previously uncultivated soils the holes should be made some months before planting and be allowed to lie fallow, but in loose, sandy soil they can be made at the time of planting.

Planting.—When the seedlings are from 10 to 20 inches high they are ready for field planting. It is then that the advantage of using pots is appreciated, for since the roots of the young plants are very sensitive and will not stand handling or exposure to the air, they are not disturbed in any way by this method, but are planted with the paper pot still enveloping them. The moisture in the soil soon causes the paper to decay and the roots have no difficulty in piercing through it.

If the plants are in flats, however, great care must be taken in lifting them from the flats to the planting holes so as not to expose or injure the root system. For lifting the seedlings from the flats to the planting holes a small hand trowel should be used, and each plant

should have the enveloping ball of earth still clinging to the roots.[1] The earth is then firmly pressed around the roots and stem, taking care to keep the plant erect and not to damage the top by pinching or breaking it, since this sort of injury may cause branching or even death.

In dry or sandy soil the plant should not be placed with the root collar at the level of the surface, but the clump of earth taken up with the plant should be placed some 3 or 4 inches below the level of the soil to form a hollow for collecting and retaining the rain. On the other hand, where there is an excess of moisture in the soil, the best results will be obtained by planting the young seedlings on the top of a small mound of earth heaped up to a height of from 12 to 18 inches or along the top ridge of a double furrow.

On very wet, marshy tracts, instead of making holes, the clumps of earth taken up with the plants are packed about with pieces of sod. These sods should be inverted, as, for example, with green marsh grass, where the vegetable decomposition furnishes nourishment necessary to the plant and the additional height improves drainage conditions.

Where the soil is at all times wet or moist and the area is subject to inundation for at least a portion of the year, as in the Everglades region, such species as *E. rostrata*, *robusta*, and *tereticornis* should be chosen. On the other hand, in localities where the soil is dry and sandy and is seldom if ever flooded, such species as *E. corynocalyx* and *resinifera* should be selected. Where there is danger from frosts, *E. viminalis*, *resinifera*, and *rostrata* will prove most resistant; *E. citriodora* is the most sensitive to frost.

It is well, when possible, to select rainy or at least cloudy days for planting in the field, and on dry areas the trees should be occasionally watered after planting until they become firmly established in their new environment.

Spacing.—The spacing will depend on the purpose for which the trees are planted, the species, and the quality of the locality as to soil and moisture.

If planted for ornament or for a windbreak, the trees may be planted from 10 to 20 feet apart in rows, with the trees of each row opposite the centers of the spaces between the trees in the adjoining rows. Since the trees grow tall and are usually clear of branches for some distance from the ground, a pleasing effect, as well as additional protection from wind, is secured by planting on the windward side of the eucalypts species which branch close to the ground.

---

[1] Though all species are susceptible to injury from root drying, *E. citriodora* (lemon-scented gum) is particularly so, and will die if the roots are exposed to the air. Sugar gum (*E. corynocalyx*) develops a strong taproot, and is therefore more difficult to handle than other species. It is not advisable to plant any of the species with naked roots.

In California, where the plantations have been intended primarily for the production of fuel wood, the trees are spaced from 8 to 16 feet apart in the rows, with the rows usually the same distance apart. In Brazil, in the plantations of the Paulista Railway, 13 feet has given the best results with the majority of species for the production of ties. With this spacing trees have been produced which at 4 years of age measured 7.6 inches in diameter. If the trees are to produce tall, straight stems, with little branching, close spacing is necessary, especially in Florida, where, because of the greater danger from wind and heavy rainstorms, close spacing, followed in three or four years by thinnings, will probably prove most satisfactory. Vigorous and thrifty plants may safely be spaced farther apart than small and poorly developed specimens. As a general rule, the more isolated the tree the more rapid is its diameter growth and the greater the volume of wood produced, and the more branchy is it apt to become.

Each species, therefore, must be considered with regard to its inherent qualities, as well as to the site on which it is to be planted. Thus, for instance, *E. globulus* and *tereticornis*, because they branch but little in the first years, may be planted about 10 feet apart, and if thinned out at the end of the sixth year will furnish a large quantity of fuel wood. *E. robusta*, on the other hand, has a naturally branchy form, and if planted less than 13 feet apart it will be at a disadvantage in the third or fourth year because of the small space allowed it.

On dry soils the trees should be planted closer than on fertile, humid soils. In Brazil the trees are spaced 9 feet apart on very dry ground, and 12 feet on firmer, damp ground, while on very level, fertile tracts or where the ground is marshy, a spacing as wide as 16 feet gives good results. Comparatively wide spacing gives the trees the necessary space to grow in and allows room for cultivation of the soil to keep down brush and harmful weeds which would otherwise compete with the young trees for light, air, and moisture. It should be remembered, however, that while too close spacing can always be remedied later by thinnings, too wide spacing can be remedied only by subsequent planting which is likely to make the cost prohibitive, and puts the younger trees at a disadvantage.

There are many advantages in laying out plantations on a systematic and orderly plan. Among these may be mentioned:

1. Better circulation of air.
2. Uniform light conditions, favoring uniform growth.
3. Equal growing space for the roots.
4. Ease of cultivation.
5. Ease of weeding.
6. Easier filling in of fail places.

7. Ease of inspection.
8. Convenience in making cuttings and thinnings.
9. Better transportation.
10. More expeditious performance of all labor.

Provided these points are considered, the choice of the system of spacing is largely a question of individual preference, unless, of course, one is limited by the size or form of the tract or the number of saplings at hand.

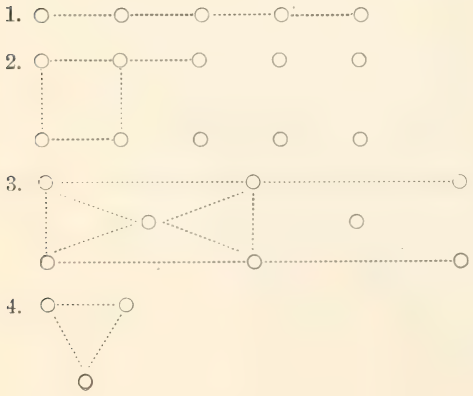
Arrangement.—In a plantation the trees in the rows may be so arranged as to form squares, rectangles, or triangles.

In the square method the distance between the trees in the rows is equal to the distance between the rows, and the trees in adjoining rows are opposite. This does not, however, bring each tree at an equal distance from each other tree, since the length of the diagonal is greater than the length of the side of a square.

The rectangular method of spacing is simply a modification of the square method. The distance between the rows is greater than the distance between the trees in the rows. If the trees are opposite each other, rectangles are formed; if the trees are opposite the centers of the spaces in adjoining rows, isosceles triangles are formed.

In the equilateral-triangle method the distance between the trees in the row is the same, but the distance between the rows is always less than the distance between the trees in the rows, and the trees in one row always stand opposite the centers of the spaces in the adjoining rows. This method probably has the most advantages. It is easy to set and place all the trees at equal distances from each other. The most trees can be planted on a given area by this method, and it is the most suitable for warm countries and sandy soils, because it makes the closest cover. The trees thus planted form regular lines in all directions from the point of view of the observer.

The various methods of spacing may be graphically represented thus:



1. Lines

2. Squares.

3. Rectangles or isosceles triangles.

4. Equilateral triangles.

In order to determine the number of plants necessary for any given area with the different methods of planting, the following formulas will be of use:

I. When planted in squares $\frac{S}{d^2}$ = the number of plants required.

II. When planted in rectangles $\frac{S}{de}$ = the number of plants required.

III. When planted in triangles $\frac{S}{d^2}$ times 1.115 = the number of plants required.

S = Number of square feet of the area to be planted.

d = Number of feet of spacing from plant to plant in the row.

e = Number of feet between rows.

For example, 1 acre = 43,560 square feet.

If the square method is chosen and a spacing of 6 feet determined upon, then the number of plants required = $\frac{S}{d^2}$.

Or substituting the real value in the formula:

$$\frac{43560}{6^2} = \frac{43560}{36} = 1{,}210 \text{ plants.}$$

Staking.—Experiments in Brazil have shown that in moist tropical countries the root system of the eucalyptus is superficial where the trees are planted in very wet situations. In part this is because there is at all times an abundance of moisture close to the surface, so the roots do not have to go far in search of water.

In places exposed to severe gales or heavy rains the plants are apt to bend, and staking may be advisable. Staked trees, however, are apt to grow tall and spindling and to lack the resistant fiber that is developed by the mechanical action of the wind. Almost any kind of wood will furnish stakes. The trees should be loosely tied to the stakes with straw, tape, or soft cotton string. Supports add to the expense of the plantation, and unless they are treated with some antiseptic preservative, they soon rot and may be the means of introducing injurious insects or fungi.

In Florida it will, as a rule, be advisable to plant closer, or to grow some agricultural crop between the rows, instead of staking.

COST OF PLANTING.

There are no exact figures as to the cost of planting eucalyptus in Florida. In California, however, extensive commercial plantations have been made, and some idea of the cost may be obtained from the experience there. In that State, from $15 to $50 per acre, with an

average, under ordinary conditions, of about $25 per acre, has been the usual cost. A number of California nurserymen make a specialty of raising eucalyptus stock and quote prices of from $8 to $30 per thousand, varying with the species and the size of the trees. Home-grown stock may, however, be easily raised at a cost of about $5 per thousand.

The cost of planting in Florida should in most cases be less than in California, if planting stock can be obtained at a reasonable price. The two principal expenses of planting are the amount of preparation necessary for the area and the cost of the planting stock. The first will vary with each particular tract. But, under ordinary circumstances in the loose sandy soils of Florida, very little preparation of the site will be necessary. Where grubbing out of palmetto is contemplated, this item will be larger.

The cost of the seedlings will also vary considerably, and if the seedlings are home grown the price per 1,000 will decrease in direct proportion to the number of the seedlings used. The cost of planting per acre will, of course, vary with the number of seedlings used to the acre; in other words, with the spacing.

When only a small area is to be planted, it will probably be more economical to procure the stock from some reliable nurseryman, provided it can be bought at the price of forest nursery stock. If large plantations are undertaken, however, it is much better, as well as cheaper, to raise the stock at home, because in Florida the nurserymen can not now supply this stock at a reasonable price. The cost may thus be greatly reduced, and the entire cost of planting under ordinary conditions should not exceed $15 to $20 per acre if home-grown stock is used.

OTHER EUCALYPTS WHICH MAY BE SUITABLE TO FLORIDA.

Besides the species found growing in Florida, many of which were not suited to the localities in which they were planted, there are a number of other species which, if introduced under proper conditions, might prove successful there on account of the similarity of the climatic conditions in their range in Australia to those of Florida.

In the selection of these species only those have been chosen that produce large trees and whose wood is useful for other purposes than fuel.

There are, of course, a number of subalpine species, such as *E. alpina*, *coccifera*, *coriacea*, *stuartiana*, and *vernicosa*, which, while they could doubtless endure the temperatures even of the northern range in Florida, are often mere shrubs or low trees about 20 feet high and of no value except as forest cover for the protection of slopes or watersheds, and for this reason are of no use in Florida.

These trees are only suggested for trial, since no specimens of them were found on which to base any conclusions as to their suitability there. In fact, all eucalyptus planting in Florida, for the present at least, should be only on a small scale and conducted rather as an experiment for the purpose of determining the best species for planting there and the various conditions of sites and soils best suited to these species. Future experiments should, however, be conducted on a more systematic basis than they have ever been in the past. When some definite data become available on these points, then the economic conditions must be considered, and these will in the end determine the advisability of planting eucalyptus on a commercial scale in Florida.

With the foregoing points in view, the following are among the best species not already mentioned:

Eucalyptus acmenoides Schauer (white mahogany).
Eucalyptus amygdalina Labill (giant eucalyptus).
Eucalyptus botryoides Smith (bastard mahogany).
Eucalyptus corynocalyx Mill (sugar gum).
Eucalyptus eugenioides Sieber (white stringy bark).
Eucalyptus gomphocephala Benth (tooart).
Eucalyptus maculata Hooker (spotted gum).
Eucalyptus meliodora Cunningham (yellow box).
Eucalyptus microcorys F. v. M. (tallow wood).
Eucalyptus obliqua l'Heritier (messmate).
Eucalyptus paniculata Smith (white iron bark).
Eucalyptus pilularis Smith (black butt).

These and the 16 already discussed have been arranged in Table 20 for convenient reference.

TABLE 20.—*Eucalypts suitable to Florida; their growth and uses*

Name of species.	Quality of timber.	Chief uses.	Size and rate of growth.
E. acmenioides, white mahogany.	Heavy, hard, and clear, but not durable in the soil.	Fuel and general purposes except under ground.	80′ high, ¾′ d. b. h.; rapid growth, tall.
E. amygdalina (var. regnans), giant eucalypts.	Splits easily, moderately hard, will float in water, not durable in ground.	Carpentry, shingles, palings, rails, shipbuilding.	400′ high, 35′ d. b. h.; very large and tall; not very rapid except on rich, fertile soils.
E. botryoides, bastard mahogany.	Close-grained, sound, and durable.	Ornamental tree, wheelwrights, shingles, fencing, fuel.	75′–100′ high; 6′–8′ d.b.h.; finally tall, growth rapid when young.
E. citriodora, lemon-scented gum.	Tall, straight tree, flexible, strong, and durable except sapwood.	Paving, vehicles, fencing, carpentry.	Tall, straight, tree grows to large size, sometimes 60′–100′ in 10–15 years.
E. cornuta, Yate.....	Very heavy, hard, tough, and elastic.	Windbreak, vehicles and implements, boat ribs.	Usually not of great height; rapid growth.
E. corynocalyx, sugar gum.	Hard and durable in soil; warps but little.	Forest cover, posts and ties, lumber, fuel.	50′–150′ high; 5′–6′ d.b.h.; rapid growth; tall and straight, little taper.
E. creba, narrow-leaved ironbark.	Hard, tough, and elastic; durable in soil.	Posts, ties, poles, piles, vehicles, and bridges.	Slender and straight; maximum height 90′; maximum d. b. h. 3′.
E. diversicolor, Karri....	Very dense, superior timber; hard, tough, and elastic.	Lumber, wheelwrights, paving, shipbuilding, ties, fuel.	100′–350′ high; 6′–20′ d. b. h.; tall and straight, fairly rapid growth.
E. eugenioides, white stringy-bark.	Splits easily; easily worked; not very hard; strong and durable.	Lumber, rails, posts, bark for roofing, mats, and strings, leaves for oil.	150′–200′ high; tall, large tree, pyramidal form.
E. globulus, blue gum....	Hard, heavy, strong, and durable.	Forest cover, fuel and oil, windbreaks, lumber.	Large tree, rapid growth.
E. gomphocephala, tooart	Very heavy, tough, and strong; difficult to split.	Timbers, shipbuilding, bridges, and docks.	100′–120′ high; 3′–4′ d.b.h.; large, symmetrical tree; fairly rapid growth.
E. gunnii, cider eucalypt.	Usually crooked; not durable in ground.	Forest cover, fuel, and charcoal.	Usually small, often dwarfed, branchy, and irregular.
E. maculata, spotted gum.	Tough and durable; bends easily.	Paving, vehicles, implements, planking, and rails.	90′ high; 3′ d. b. h.; tall and straight; moderate celerity.
E. marginata, jarrah.....	Hard, dense, and very durable.	Timber, piles, and ties; kino.	Very large, tall, and slender; often two-thirds clear length.
E. meliodora, yellow box.	Hard, tough, and durable.	Spokes, rollers, cogs, heavy framework, poles, posts, and fuel; for honey.	Medium size, rather spreading; maximum height, 250′; maximum d. b. h., 6′–8′.
E. microcorys, tallow wood.	Heavy and strong; pale yellow to brown; very durable; does not shrink or burn readily.	Building material, paving blocks, posts, rails, ties, vehicles.	Fine timber tree; maximum height, 300′; tall and straight.
E. obliqua, messmate....	Straight grained, easily split; second class as timber, but good for rails and shingles.	Rough lumber for building; fuel.	Tall and very rapid growth; maximum height, 300′; maximum d. b. h., 10′.
E. paniculata, white iron bark.	Very dense, hard, and durable.	Beams and building material, vehicles, ties, and posts.	Small to medium size, maximum height, 100′.

under native conditions and their possible range in Florida.

Climatic requirements.	Soil requirements.	Remarks.	Region for planting in Florida.
Absolute maximum, 113°; absolute minimum, 22°; 20″–60″ rainfall.	Prefers damp soil; grows well on sand or clay.	Very frost resistant	Merritts Island to Tampa and south.
Victoria and New South Wales: Endures low temperatures, but not dry heat. Absolute minimum, 3°; average maximum, 70°.	Moist or swampy situation with average moisture in soil.	Roots extend upward like the fig; protection essential.	Southern Brevard, De Soto, and Manatee Counties, and south.
Absolute maximum, 102°; absolute minimum, 25°; rainfall, 20″ per annum.	Sandy localities close to seacoast; prefers moist, sandy tracts near coast or in river bottoms.		Dade, Lee, and Monroe Counties.
Queensland: Average maximum, 101°; average minimum, 26°; rainfall, 20″–50″.	Prefers fresh or moist but not wet soils.	Best adapted to lowlying, semitropical countries.	Palm Beach, Dade, Monroe, and Lee Counties, and north along coast to Tampa on west and Juno on east.
Absolute maximum, 116°; absolute minimum, 23°; does well even in exposed situations; rainfall, 25″.	Prefers moist soil; will make fair growth in poor sand.	Endures much rain but is also drought resistant.	Do.
Absolute maximum, 116°; absolute minimum, 27°–30°; absolute minimum, 20°–35° in California.	Profits by moisture but will endure drought.		Do.
Absolute maximum, 113°; absolute minimum, 22°; rainfall, 40″–60″.	Content with poor soil		Palm Beach, Dade, Monroe, Lee, De Soto, Manatee, and southern Brevard Counties.
Absolute maximum, 105°; absolute minimum, 27°–30°; rainfall, 30″–40″.	Does best near coast on granite soils.	Prefers moist climate; quite frost resistant; does not endure dry heat.	Fort Myers to Miami in warm coast regions.
Absolute maximum, 110°; absolute minimum, 3°–20°; 40″–60″ rainfall.	Sandy soil or low, humid regions.	Will not endure dry heat.	Brevard, Orange, Lake Sumter, and Hernando Counties, and south.
Absolute maximum, 106°; absolute minimum, 17°; rainfall, 20″–60″.	Very varied; does best on deep, fresh soils; shuns impervious subsoil and calcareous or brackish soils.		Dade, Monroe, and Lee Counties, and possibly a little farther north.
Absolute maximum, 105°; absolute minimum, 30°; rainfall, 40″.	Always on limestone formation and near seacoast.		Dade, Monroe, and southern Lee Counties, and along west coast to Hillsboro County.
Absolute maximum, 103°; absolute minimum, 3°–20°; rainfall, 40″–60″.	Larger trees on alluvial flats.	Dwarf form of this species grows at altitudes of 4,000–5,000 feet in Australia, and is quite frost hardy.	North to Eustis.
Absolute maximum, 104°–105°; absolute minimum, 21°; rainfall, 30″–50″.	Grows on ridges and poor soils in coast districts.		Brevard, De Soto, and Manatee Counties, and south.
Absolute maximum, 115°; absolute minimum, 27°; rainfall, 20″–30″.	Great variety of soils, but prefers fresh or moist but well-drained situations.		Palm Beach, Dade, Monroe, and Lee Counties.
Average maximum, 107°; average minimum, 20°; rainfall, 40.″	Prefers fertile soil, but will grow on poor soil and hillsides.	Coast plains and foothills.	Southern Brevard, southern De Soto, and Manatee Counties, and south along coast.
Average maximum, 112°; average minimum, 25°; rainfall, 40″–60″ uniformly distributed.	Sandy country and coast side of the ranges.		Dade, Monroe, Lee, and Manatee Counties.
Average maximum, 105°–110°; average minimum, 14°–20°; rainfall, 50″.	Grows on poor, stony ranges and there obtains large size, or on tight, barren, sandy soils if not subjected to prolonged drought.		Whole range north to Eustis.
Average maximum, 109°; average minimum, 29°; rainfall, 60″.	Poor ridges New South Wales and along the coast, but makes best growth on moist soils.	Will not endure drought or extreme heat.	Southern Dade and Monroe Counties.

TABLE 20.—*Eucalypts suitable to Florida; their growth and uses*

Name of species.	Quality of timber.	Chief uses.	Size and rate of growth.
E. pilularis, black butt	Hard, strong, and durable in ground.	Building material, poles, posts, and ties; honey producer.	Medium size to tall and slender; maximum height, 300′; maximum d. b. h., 15′.
E. polyanthema, Australian beech.	Heavy and hard	Fuel, ties, vehicles	Medium size
E. resinifera, red mahogany.	Strong, hard, and durable.	Lumber, piles, posts, ties, paving, shingles, etc.; turnery and furniture; fuel.	60′ in 10 years
E. robusta, swamp mahogany.	Reddish, hard to split, brittle, but very durable.	Posts and ties; fuel; kino; shade tree.	Medium size; spreading habit; slow growing.
E. rostrata, red gum	Hard, strong, and durable; difficult to season.	Posts, piles, and ties, girder wood, paving blocks, lumber, and fuel.	Above medium; fairly rapid growth; maximum height, 250′; maximum d. b. h., 16′.
E. rudis, flooded gum	Not much known. Durable in soil; posts in California.	Windbreaks, shade tree, fuel; honey and oil.	Medium size, vigorous growth when young; reproduces freely.
E. saligna, New South Wales blue gum.	Pale red, straight grain, and easy to work.	Shipwrights, wheelwrights, paving.	Lofty, straight stem; maximum height, 100′; maximum d. b. h., 6′–7′.
E. siderophloia, broad-leaved iron bark.	Strong, hard, and durable.	Bridges, posts, ties, spokes, and fuel.	100′ high; 3′–4′ diameter.
E. tereticornis, gray gum.	Hard, heavy, and durable, inlocked grain, red color, durable in soil.	Posts, shipbuilding, paving blocks, lumber, fuel.	Medium size and fairly rapid growth (⅔ blue gum) in California; maximum height, 100′–160′; maximum d. b. h., 5′–6′.
E. viminalis, manna gum.	Inferior quality; not durable under ground.	Forest cover and windbreaks, and fuel; oil and honey, melitose-manna.	Large tree and rapid growth.

under native conditions and their possible range in Florida.

Climatic requirements.	Soil requirements.	Remarks.	Region for planting in Florida.
Average maximum, 106°; average minimum, 20°; rainfall, 40″.	Best on fresh, moist, but not wet soils.	Coast regions of southeast Australia. Endures neither very high nor very low temperatures.	Brevard, De Soto, and Manatee Counties, and south.
Average maximum, 116°; average minimum, 16°; rainfall, 40″–60″.	Requires good soil.....	Resistant to extremes of heat and cold. Pleasing shade tree, because of blossoms, and a good tree for windbreaks.	All of southern Florida, and as far north as Eustis.
Average maximum, 111°; average minimum, 19°; rainfall, 40″–50″.	Variety of soils. Not in stagnant swamps.	Coast-region tree. Resists white ants and will not discolor paint. Frost resistant.	Whole range of eucalyptus in Florida, except the Everglades.
Average maximum, 107°; average minimum, 25°; rainfall, 40″–60″ (uniform).	Best near coast in warm swampy localities. Will grow even where occasionally inundated with brackish water.	Very free from insect damage. Must have abundant water in soil. Requires sea air. Subject to wind breakage.	Palm Beach, Dade, Manatee, and Lee Counties.
Minimum temperature, 15°–25°; will endure much heat, severe drought, and considerable frost.	Prefers moist soils, river banks, and valleys.	Will stand inundation for considerable periods. Frost resistant.	Dade, Monroe, Lee, southern De Soto, Manatee, and Brevard Counties.
Average maximum, 116°; average minimum, 31°; rainfall, 40″.	Low flats and banks of rivers.	In southwest United States endures maximum, 110°–118°, and minimum, 15°–18°.	North to Eustis.
Average maximum, 105°; average minimum, 20°; rainfall, 40″–50″.	Variety of soils; prefers deep, moist soil. Will not endure drought.	Warm coast regions only.	Miami, Fort Myers, the Everglades.
Average maximum, 110°–112°; average minimum, 18°–20°.	Prefers moisture; does not thrive in dry, hot, interior valleys.	Kino obtained from this species.	Dade, Monroe, Lee, southern De Soto, Manatee, and Brevard Counties.
Average maximum, 104°–110°; average minimum, 20°–27°; rainfall, 40″–60″.	Alluvial country or near water courses, or warm sites near coast.	Frost resistant and fine decorative tree.	Dade, Monroe, Lee, southern De Soto, Manatee, and Brevard Counties. Also Ocala, Myers, and Tampa.
Average maximum, 110°; average minimum, 3°–20°; rainfall, 40″–60″.	Thrives near coast, on poor and sandy soil and in moist or even swampy places.	Requires protection from winds. Subject to attack of Cicadæ. Frost resistant. Good for decorative planting.	Whole range. Gainesville, Ocala, Tampa.